UNIVERSITY OF SOUTHAMPTON

Applying Gamification to Teaching Cyber Security

By

Reece Buckle

Project Supervisor: Dr Nawfal Fadhel

Second Examiner: Dr Andrew Sogokon

A project progress report submitted for the award of BSc Computer Science

Department of Electronics and Computer Science

Novemeber 2020

Abstract

Due to the ever changing landscape of technology and cyber security, there is a requirement to promote cyber security awareness where possible. Typically this is done via government endorsed training schemes, website campaigns, fliers and posters and gamified strategies. As a strategy towards this problem, this report investigates the use of gamification mechanics in order to teach cyber security concepts in a fun and interactive way. Furthermore, despite many serious cyber security games being developed for Universities and businesses, there are a lack of cyber security games that are also relevant and available to the general public. Therefore, this project will aspire to develop a multiplayer board game in which cyber security vulnerabilities are illustrated through mini-game challenges, cyber attack & defence cards and a contextually appropriate setting. The goal of this project is to produce a game which is relevant for both businesses and the public domain - and ultimately leaves the player more conscientious in regards to how they interact with technology.

1 Statement of Originality

I have read and understood the ECS Academic Integrity information and the University's Academic Integrity Guidance for Students.

I am aware that failure to act in accordance with the Regulations Governing Academic Integrity may lead to the imposition of penalties which, for the most serious cases, may include termination of programme.

I consent to the University copying and distributing any or all of my work in any form and using third parties (who may be based outside the EU/EEA) to verify whether my work contains plagiarised material, and for quality assurance purposes.
I have acknowledged all sources, and identified any content taken from elsewhere.

I have not used any resources produced by anyone else.

I did all the work myself, or with my allocated group, and have not helped anyone else.

The material in the report is genuine, and I have included all my data/code/designs.

I have not submitted any part of this work for another assessment.

Contents

2 Introduction

2.1 Problem Summary

Problem Statement

Despite the existence of many cyber security awareness programs, there is still a lack of effective, widespread cyber security training

As modern-day technology is ever evolving, the number of users who interact with technology on a daily basis increases consequently. As a result, the risk of an individual, or business, becoming a victim to cyber-crime increases proportionately. In particular, small and medium-sized businesses (SMBs) are the biggest sectors targeted by cyber-criminals [1], which stem from issues such as budget restraints and expressing a lack of understanding towards cyber security concepts.

In fact, as a consequence of COVID-19 changing the dynamic of industry standards this year, a statistical analysis from May 2020 (UK) showed that individuals experiencing targeted hacking increased by 77.41% - in comparison with the previous year [2]. This is most likely due to the fact that employees are encouraged to work from home via their personal computers. Consequently, this has fed into a new strategy whereby cyber-criminals are moving laterally into organisational infrastructure by targeting and infecting employees at their less secure personal computers [3].

In regards to this problem, this paper will explore the effectiveness of educational games - which has been shown to have an advantage on the learning outcome in comparison with traditional training material [4]. Therefore, this paper presents the following research question and hypothesis:

Research Question

Does teaching cyber security through a gamified medium improve user confidence in protecting against cyber attacks?

Hypothesis

Creating an educational cyber security game will leave users feeling more confident and aware with regards to cyber security concepts

2.2 Goals & Scope

The goal of this project is to investigate how to effectively apply gamification mechanics in order to teach cyber security principles appropriately. The expected result of this project is to create a multiplayer, online tabletop board game.

3 Literature Review & Research

3.1 Introduction

To date, this report includes an evaluation of literature review pertaining to pre-existing cyber security games, mechanics for game-based learning and current trends in cyber security training methodologies.

3.2 The Problem with Current Cyber Security Training Programs

This report will specifically analyse the shortcomings and difficulties that relate to current training programs designed for small and medium-sized businesses [1, 5].

Problem	Description
1	SMBs can be heavily constrained by a limited budget
2	SMBs can be difficult to reach as they do not understand the severity of data breaches
3	SMBs are often distracted by the operational requirements for setting up and running a small business
4	SMBs struggle to identify their assets in terms of the risks associated with them

In regards to the delivery of training programs, providing generalised cyber security advice (from an independent advisor) has been shown to have little effect on changing the behaviour of employees within SMBs [1, 6]. Furthermore, traditional training simulations (including gamified video simulations) are generally undertaken in a formal environment which leads to a situation of recipients not absorbing the information well [2].

The methodology of cyber security exposure is also important as whilst employees may understand some general information about the vulnerability demonstrated, they may still fail to see how it relates to their workplace environment [5] or how they link together in a multifaceted social engineering attack [6]. This last point emphasises the need for widespread conceptual training in cyber security.

3.3 A Critical Analysis of Pre-Existing Cyber Security Games

For a full account of educational games and resources reviewed, please see Appendix A. My methodology for reviewing cyber security games was two fold:

- First - utilising the Google search engine with the following keywords: ‘cyber security’, ‘serious games’, ‘gamification’ and ‘game-based learning’ in order to look for any widely available games. These commonly returned web applications designed for students in all stages of education.

- Second - utilising Google Scholar and the IEEE Database with similar keywords in order to find academic papers which either reviewed other educational games, or were proposing one. For the games that were not available online, I summarised the key information and research results from the academic source material.

Building on from this, I concluded the following categories of educational game-based learning strategies in order to identify the most appropriate medium for the purpose of answering the research question and hypothesis established in this project.

3.3.1 Web Applications

Advantages	Disadvantages
Simple point and click interactivity	Can lack depth and relevance to a specific target (often designed for students)
Easily accessible anywhere with an internet connection	Not suitable for offline usage
Cheap development cost & time	

3.3.2 Video / Simulation

Advantages	Disadvantages
Contextually appropriate for use within the workplace [5]	Not appropriate for the general public & students
Accessible both online & offline	Requires multiple play-throughs if scenarios are divergent
	Typically not very fun as undertaken in a formal environment [5]

3.3.3 Cooperative Tabletop

Advantages	Disadvantages
Encourages social engagement and team-working	Requires multiple players
Cheap to prototype and produce a physical implementation	Requires much fine-tuning of rules and mechanics implemented
Encourages thinking strategically	

3.3.4 Task Management

Advantages	Disadvantages
Easy to employ around current learning strategies (within the classroom or workplace)	Requires long term evaluation of effectiveness
Perfect example of procedural learning [7]	Not a true application of an educational game

3.3.5 Single Player

Advantages	Disadvantages
Immersive and engaging typically through story driven content	High development cost & time
Often places the player as a white / black hat hacker which encourages adversarial thinking	Lack of exploration on how to prevent vulnerabilities as a target

3.4 Difficulties that Pre-Existing Cyber Security Games Face

Many of the educational games reviewed relied heavily on presenting facts and then subsequently quizzing the user with a related question. However, users can utilise common sense to rule out incorrect answers thus fail to invoke critical thinking and do not keep the user engaged.

As a solution, gamified strategies should incorporate a variety of factual, conceptual and procedural learning methodologies [7]. In particular, a strong conceptual understanding should be prioritised due to the rapidly changing landscape of cyber security in which cyber-criminals will always be engineering new attack vectors [6]. Therefore, it is imperative for end-users to be able to adapt their way of thinking when interacting with new technology.

For procedural learning, both Nova Cyber Lab [8] and Classcraft [9] (Appendix A) exemplify this by beginning with simple challenges and progressively increasing the difficulty of said challenges as the user progresses. Unlike the other games reviewed, Classcraft is unique as it encourages users within a team to continually expand upon their knowledge by working towards new goals and objectives collaboratively. Furthermore, this system incorporates real-world rewards and punishments to encourage user-engagement.

Finally, many serious cyber security games are designed primarily for university students and businesses but are not readily available to the general public [7]; this agrees with my own research - whereby many of the publicly accessible educational games I reviewed were considerably outdated and not intended for the general public.

3.5 Why Use a Game-Based Learning Approach?

As identified above, many challenges that arise when attempting to educate employees within the business environment occur due the formality of traditional training methodologies in which employees will aim to complete as fast as possible [6]. This absentmindedness often results in training content which is not absorbed effectively [1, 6]. However, these challenges can often be overcome with game-based learning strategies [4].

A summary of key strengths and motivations for gamification [4, 10, 11, 12, 13] include:

- Rapid progress paired with instant feedback
- Strong user engagement
- Allows the user to learn from mistakes in a safe, non punishing environment which would otherwise discourage exploration (due to the fear of failure)
- Serves as a platform to encourage self-learning at the user's desired pace
- Allows the user to become deeply immersed into the 'game - world' where learning feels like a secondary objective
- Relatively cheap and low cost to produce in comparison to larger training schemes
- Requires little to no supervision
- Easy to distribute across multiple platforms and incorporate into the workplace
- Easy to integrate within events such as hackathons and other cyber security awareness gatherings
- Use of an integrated rewards system such as badges, hidden achievements and the desire to win
- Educationally appropriate by incorporating a structure/story that is contextually similar to the real world

3.6 Appropriate Gamification Mechanics

Forde's report [14] identifies the following gamification mechanics in order to increase the adoption rate of effective cyber security standards within the workplace:

- Avatar / User Profile
- Badges / Privileges
- Challenge
- Competition
- Collaboration
- Feedback / Guidance
- Goals / Objectives
- Incentives / Rewards
- Leaderboards
- Points System
- Progress / Levels
- Role Playing
- Story
- Tips / Hints System

3.7 Conclusion

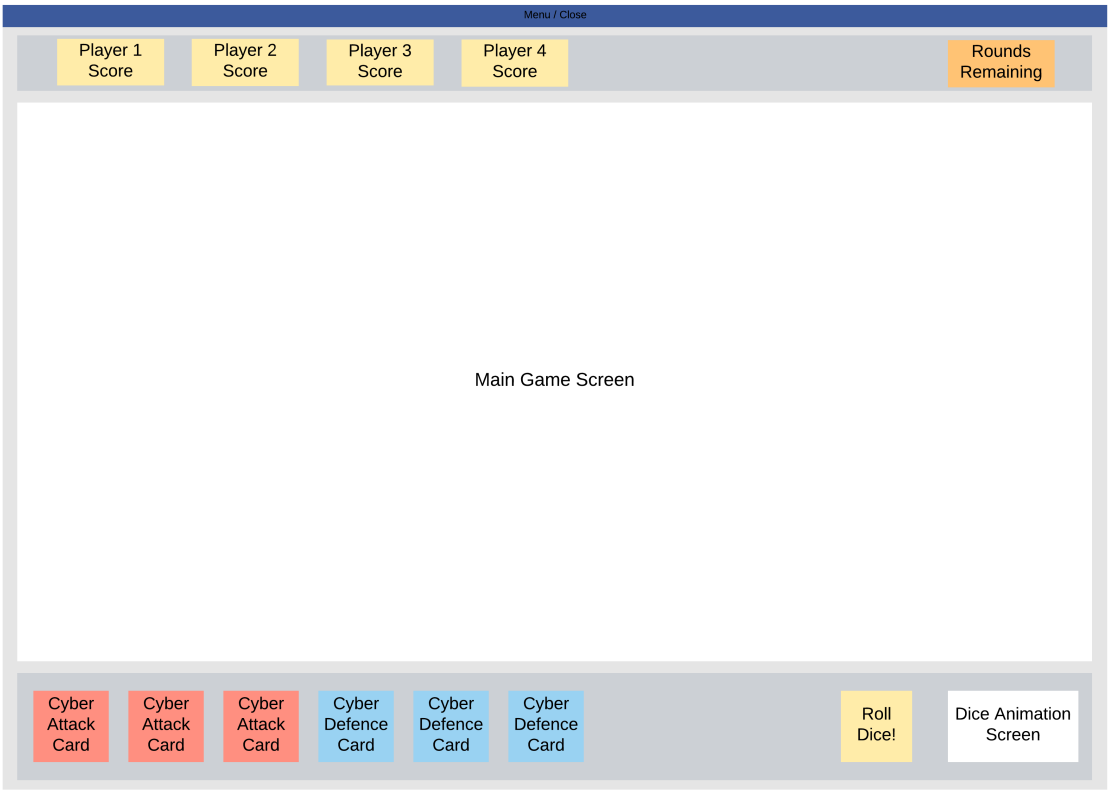
To summarise, cyber security training programs need to be cost effective and target the specific needs and requirements of the workplace in order to be viable for SMBs. Furthermore, where traditional training methodologies fall short, gamified strategies can offer a more cost-effective solution for teaching relevant cyber security concepts. However, unless the game in question has a strong story (e.g. Hacknet [15]), many educational games reviewed included a number of flaws which stem from lack of gamified mechanics that encourage meaningful play. Forde's report [14] identifies these key mechanics as multiplayer, leaderboards, points system and competition which can be deemed as the most effective in motivating people to participate and learn about a subject that they would otherwise have little interest in. Lastly, there is a gap in the public domain in which an appropriately designed cyber security game could be of use.

4 The Proposed Final Design

4.1 Proposed Idea

The proposed application is a 2-4 multiplier board game. As identified in the literature review, cooperation and competition are two of the most effective mechanics for engaging meaningful game play. The application will be loosely inspired from Mario Party's format, in which players will roll a dice in order to move around tiles on the map. An initial map idea is a typical working office where the goal is to race to navigate towards significant rooms where vulnerabilities are located (such as memory sticks laying around, unattended computers etc). The core game-play will involve collecting these objects and, in the process of moving, players may land on optional item tiles which will drop a defence or attack card respectively; these cards can be used against other players to handicap their movements or score. Finally, between each round, (or if a player lands on a certain tile), a mini-game challenge pertaining to a cyber security concept will be triggered in which the players can compete against each-other.

Figure 1: Wireframe illustrating the Board Game UI



4.2 Functional Requirements

Requirement	Description
Multiplayer	Users are able to play in turns with other users
Web Accessible	Users are able to access the the game lobby from their web browser
Game is Playable	Users are able to play a full version of the game
Account Registration	Users are able to register and login
Save Profile	Users profiles are saved (and earned achievements integrated with MySQL)
Achievements	Users are able to earn achievements from progress
Score / Leaderboard	Users can see their score vs other players
Single Player Mode	Users can play single player (versus computer AI)

4.3 Non - Functional Requirements

Requirement	Description
Availability	The application should be accessible on both desktop web browsers and via mobile tablets
Ease of use	The application should be easy to learn and understand
Accessibility	The application should cater for disabilities such as colour blindness
Security	The application should be secure and protect user's credentials should account registration be implemented
Factually Correct	The application should be factually correct with any cyber security concepts explored
Performance	As a web browser game, it should be relatively smooth to both play and load (with quick multiplayer response times). However, latency is less of an issue given the turn-based mechanic.
Scalability	Should be able to deal with 2-4 connected users per game

4.4 A Brief Account of Work to Date

- Appropriate mechanics have been identified and researched from pre-existing serious cyber security games and literature review

- Appropriate Game Engine (Unity), cloud services (Photon Engine) and APIs have been identified in order to create and host the game

- Cyber security vulnerabilities, game - objects and mini-game ideas for the final implementation have been brainstormed

- A wireframe of the game interface has been mocked up

4.5 A Justification of this Approach

As identified in the literature review, a list of issues identified with pre-existing cyber security games (and comparable training methods) can be justified as follows:

1. Making a publicly available game is both cheap to produce and distribute which meets the budget constraints of SMBs. This also complements the lack of cyber security games available within the public domain

2. A board game with a workplace setting is contextually appropriate for identifying the risks present within SMBs

3. The inclusion of mini-games and vulnerabilities as objectives can be used to explore concepts and trends within cyber security

4. Cyber attack & defence cards encourage the player to consider the perspective of both cyber attackers and themselves (as a potential target to cyber-criminals)

5. Multiplayer is key for encouraging meaningful play as well as overcoming the pitfalls of traditional training methodologies

6. A score board with achievements and objectives encourage competition between players

7. Using a similar rule-set to Mario Party as well as incorporating the identified mechanics in Forde's report [14] reduces the likelihood of developing a game which isn't fun, effective and/or fails to the meet the requirements outlined above

5 A Plan of Remaining Work & Project Planning

5.1 Remaining Work

Task / Requirement	MoSCoW	Difficulty
Establish Multiplayer Networking	Must	High
Web Browser Accessible	Should	Medium
Logic for Turn Based Movement	Must	Medium
Add Graphics & Sound Assets	Must	Low
Add Cyber Attack & Defence Items	Must	Low
Add Objectives & Goals	Must	Low
Add Minigame Tiles & Rounds	Should	High
Add a Score / Leaderboard	Should	Low
Account Registration	Could	Medium
Save Profile	Could	Medium
Add Achievements	Could	Low
Test the Application	Could	High
Complete the Application	Must	Very High
Obtain Feedback of Application	Could	Medium
Single Player Mode (with AI)	Won't	Very High

Single player mode is a desirable feature however multiplayer is more appropriate within the context of a board game and meets the requirements of collaboration and competition.

5.2 Project Management Tools & Techniques

Tools	Description
Southampton GitLab	Ability to share a visual representation of tasks completed via GitLab's Boards, Issues and Milestones as well as handle version control
Trello	Visual representation for setting daily & weekly tasks
Workona	Chrome extension for streamlining online research into a succinct workplace
Menderley	Reference management for supporting literature
Google Drive	Cloud storage for research, recording minutes and sharing documents
Unity Engine	Game engine for developing for the Web (WebGL)
Photon	Cloud service for hosting multiplayer servers online
Vagrant	Establishing a virtual software development environment

5.3 Gantt Chart for Phase 1

Week Beginning	1	2	3	4	5	6	7	8	9	10
Date beginning	**Oct 5**	**Oct 12**	**Oct 19**	**Oct 26**	**Nov 2**	**Nov 9**	**Nov 16**	**Nov 23**	**Nov 30**	**Dec 7**
Planning										
Project Brief										
Literature Review										
Submit Project Brief		x								
Project Planning / Gantt Draft										
Form Hypothesis / Research Question										
Research										
Review Gamemaking Toolkit										
Research Pre-Existing Cyber Security Games										
Research Game Mechanics										
Brain Storm Game										
Research Dev Tools/Languages/APIs										
Write Progress Report										
Submit Report										x

5.4 Gantt Chart for Phase 2

The proposed schedule for semester 2 accounts for a two-week examination period and aims to finish 6 weeks before the deadline (with the final two weeks set by for testing and analysis). Should the project takes more time than anticipated, feedback-testing can be missed.

Week Beginning	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Date beginning	**14/12**	**21/12**	**28/12**	**4/1**	**11/1**	**18/1**	**25/1**	**1/2**	**8/2**	**15/2**	**22/2**	**1/3**	**8/3**	**15/3**	**22/3**	**29/3**	**5/4**	**12/4**	**19/4**	**26/4**
Implementation				**Exams**																
Wireframes of Board/UI																				
Set Up Dev Envrionment																				
Set Up Multiplayer Networking (Photon)																				
Create Board Outline																				
Turn Based Logic																				
Graphics & Sound Assets																				
Attack & Defence Items																				
Add Objectives & Goal																				
Minigame Tiles / Rounds																				
Score Board																				
Login Authentication																				
Profile & Achievements																				
Testing / Evaluation																				
Write Unity Test Cases																				
Obtain Ethics Approval																				
Obtain Feedback from Playtesters																				
Analyse Feedback																				
Write Final Report																				
Submit Final Report																				**x**

5.5 Risk Assessment

Risk	Prob (1 - 5)	Severity (1 - 10)	Risk Exposure (P X S)	Mitigation
Project deadlines not met	3	10	30	Weekly meetings with project supervisor to continuously evaluate progress and apsiring to finish early in order to provide a buffer period
Not obtaining Ethics Approval in time	3	9	27	Submit identified research questions by no later than mid Janurary
Online Multiplayer not being possible due to limitations/pricing of cloud server hosting	3	8	24	Possibility to incorporate LAN multiplayer functionality by utilising the Unity Mirror API. Failing this, it would suffice to implement multiplayer co-op from the same system
Relevant cyber security principles are not effectively taught	3	7	21	By identifying an appropriate target demographic and the most appropriate cyber security content to teach
Over/under estimating scope of implementation	3	7	21	Aspired project is relatively modular whereby smaller features (identified as Could in the MoSCoW analysis can be foregone if required. There is also the alternative of implementing Single Player AI instead of multiplayer functinality
Final project doesn't relate to original problem statement/hypothesis	2	9	18	Continuously referring back to the initial problem statement and hypothesis
Sickness / Flu / Mental Health difficulties from Covid19	2	8	16	By exercising daily and reaching out for support earlier (rather than later)
Complications due to Covid19	5	3	15	Aspired project will utilise online multiplayer (for remote gameplay), alongside Microsoft Teams, Discord & GitLab for communication and development
Gamified mechanics are not appropriately utilised	2	7	14	By identifying key mechanics through literature and game review and prioritise the most fundamentally important for this project
Stolen work/data from: cloud storage account being compromised / downloading ransomware	1	10	10	By using randomally generated passwords and 2FA as well as manually backing up important files weekly
Loss of work/data from: PC breaking / Cloud storage servers failing	1	10	10	Storing a copy of work across multiple platforms (Southampton Git, Locally and Google Drive)

6 Bibliography

[1] M. Bada and J. R. Nurse, "Developing cybersecurity education and awareness programmes for small-and medium-sized enterprises (smes)," *Information & Computer Security*, 2019.

[2] D. Buil-Gil, F. Miró-Llinares, A. Moneva, S. Kemp, and N. Díaz-Castaño, "Cybercrime and shifts in opportunities during covid-19: a preliminary analysis in the uk," *European Societies*, pp. 1–13, 2020.

[3] H. S. Lallie, L. A. Shepherd, J. R. Nurse, A. Erola, G. Epiphaniou, C. Maple, and X. Bellekens, "Cyber security in the age of covid-19: a timeline and analysis of cyber-crime and cyber-attacks during the pandemic," *arXiv preprint arXiv:2006.11929*, 2020.

[4] J.-N. Tioh, M. Mina, and D. W. Jacobson, "Cyber security training a survey of serious games in cyber security," in *2017 IEEE Frontiers in Education Conference (FIE)*. IEEE, 2017, pp. 1–5.

[5] J. Abawajy, "User preference of cyber security awareness delivery methods," *Behaviour & Information Technology*, vol. 33, no. 3, pp. 237–248, 2014.

[6] H. Aldawood and G. Skinner, "Reviewing cyber security social engineering training and awareness programs—pitfalls and ongoing issues," *Future Internet*, vol. 11, no. 3, p. 73, 2019.

[7] R. Roepke and U. Schroeder, "The problem with teaching defence against the dark arts: A review of game-based learning applications and serious games for cyber security education." in *CSEDU (2)*, 2019, pp. 58–66.

[8] "Cybersecurity Lab - NOVA LABS," Accessed: 14-12-2020. [Online]. Available: https://www.pbs.org/wgbh/nova/labs/lab/cyber/

[9] "Classcraft," Accessed: 14-12-2020. [Online]. Available: https://www.classcraft.com/

[10] S. Hart, A. Margheri, F. Paci, and V. Sassone, "Riskio: A serious game for cyber security awareness and education," *Computers & Security*, p. 101827, 2020.

[11] A. Jøsang, V. Stray, and H. Rygge, "Threat poker: Gamification of secure agile," in *IFIP World Conference on Information Security Education*. Springer, 2020, pp. 142–155.

[12] J. Anvik, V. Cote, and J. Riehl, "Program wars: a card game for learning programming and cybersecurity concepts," in *Proceedings of the 50th ACM Technical Symposium on Computer Science Education*, 2019, pp. 393–399.

[13] T. Denning, A. Lerner, A. Shostack, and T. Kohno, "Control-alt-hack: the design and evaluation of a card game for computer security awareness and education," in *Proceedings of the 2013 ACM SIGSAC conference on Computer & communications security*, 2013, pp. 915–928.

[14] A. T. Forde, "A gamification toolkit for improving cyber security standards adoption," Master's thesis, University of Southampton, September 2020.

[15] "Hacknet," Accessed: 14-12-2020. [Online]. Available: https://hacknet-os.com/

[16] "Cyberland - Cyber Security Challenge UK," Accessed: 14-12-2020. [Online]. Available: https://www.cybersecuritychallenge.org.uk/what-we-do/schools-programme/cyberland

[17] "Game of Threats," Accessed: 14-12-2020. [Online]. Available: https://www.pwc.co.uk/issues/cyber-security-services/game-of-threats.html

[18] "Webonauts Internet Academy," Accessed: 14-12-2020. [Online]. Available: https://learningworksforkids.com/apps/webonauts-internet-academy/

[19] "Targeted Attack - The Simulation," Accessed: 14-12-2020. [Online]. Available: http://targetedattacks.trendmicro.com/

[20] "Keep Tradition Secure," Accessed: 14-12-2020. [Online]. Available: https://keeptraditionsecure.tamu.edu/

[21] "Cyber Awareness Challenge USA," Accessed: 14-12-2020. [Online]. Available: http://sgschallenge.com/cyber-awareness-challenge/

7 Appendices

7.1 A Review of Cyber Security / Serious Games

The following games can be found online at: [16, 17, 18, 19, 9, 8, 20, 15, 21] (in order).

Game	Cyberland - Cyber Security Challenge
Game Type	Web Application Point and Click
Target Audience	Children, Teenagers, Students (High school - University level)
Description	Cyber Security Challenge UK is an organisation which hosts a variety of mini games (Cyberland), competitions and networking between schools, universities, businesses and government institutes
Key Teachings / Findings	Examples of minigames which teach: - Identifying phishing emails - Command line simulator - Firewall simulator (analyse incoming network activity and grant/deny requests - Database simulator -(remove old accounts, sanitise personal information, check admin clearance) - Coffee shop network simulator (using unprotected networks vs VPN and shoulder surfing) - IoT home simulator - making sure all IoT devices have latest software update - Courthouse simulator - demonstrating cyber security laws and ethics - Cipher cracking simulator - Password strength making game - Data leak mystery solver - Malware simulator (demonstrates different types of malware/ransomware and they work)
Mechanics Identified	• Competition • Feedback / Guidance • Tips / Hints • Story • Goals / Objectives

Game	Game of Threats
Game Type	Multiplatform - (Mobile, Tablet, PC), Multiplayer
Target Audience	Businesses - Employees
Description	Employees are split into teams of attackers and defenders who work together to simulate scenarios of cyber attacks and appropriate responses
Key Teachings / Findings	- Teaches people about cyber security trends and to understand the consequences of cyber attacks and what you can do to mitigate the impacts - Helps people understand the mindset of both attackers and defenders- - Prompts discussion with colleagues in teams to popularise cyber security readiness
Mechanics Identified	● Feedback / Guidance ● Incentives / Rewards ● Competition

Game	Webonauts Internet Academy
Game Type	Web Application Point and Click Side Scroller
Target Audience	Children (aged 7-12)
Description	Puts the player as an astronaut in which they can rank up their status by demonstrating smart and good behaviour
Key Teachings / Findings	Teaches children: - How to be respectful online - How to protect themselves online - Looking for trustful website certificates - Establishing privacy settings on profile - Not giving out and using weak passwords
Mechanics Identified	● Avatar ● Feedback / Guidance ● Tips / Hints ● Badges / Privileges

Game	Targeted Attack
Game Type	Web Application Point and Click
Target Audience	Businesses - Employees
Description	Targeted Attack places you as a CEO in a simulation of business growth and defence from cyber attacks
Key Teachings / Findings	Teaches employees: - Smart and safe decision making - Threat level of different types of cyber attacks and how to mitigate them
Mechanics Identified	● Feedback / Guidance ● Story ● Challenge

Game	Classcraft
Game Type	Web Application, Point and Click, Multiplayer, Productivity - Management
Target Audience	School Students
Description	Classcraft incorporates gamifiication principles through the use of management software to set goals and challenges within a classroom and encourages teamwork between students
Key Teachings / Findings	Teaches employees: - Smart and safe decision making - Threat level of different types of cyber attacks and how to mitigate them
Mechanics Identified	● Avatar ● Leaderboard ● Competition ● Badges / Privileges, ● Feedback / Guidance ● Goals / Objectives ● Incentive / Rewards ● Point Systems

Game	Cyber- security Lab
Game Type	Web Application Point and Click
Target Audience	Businesses - Employees
Description	Allows the player to choose a business they'd like to start and require them to spend defence points in different areas of cyber defence
Key Teachings / Findings	Teaches children via minigames: - how to spot phishing emails - how to construct strong passwords - Simple programming principles
Mechanics Identified	● Avatar ● Achievements ● Progress / Levels ● Point System ● Tips / Hints ● Feedback / Guidance

Game	Keep Tradition Secure
Game Type	Web Application Point and Click
Target Audience	University Students
Description	You are a campus student trying to take down a fictional cyber criminal by making smart cyber security decisions
Key Teachings / Findings	Teaches students: - Smart decision making on campus (using public networks vs campus VPN) - Quiz based - Gives out prizes for student participants
Mechanics Identified	● Tips / Hints ● Feedback / Guidance ● Rewards / Incentives

Game	Hacknet
Game Type	Downloadable, Single Player, Point and Click
Target Audience	Gamers
Description	Hacknet is a paid game (on Steam) which is a terminal-based hacking simulator
Key Teachings / Findings	Teaches player: - How to navigate networks - Search for hidden files/folders - Authorisation bypass - Heavy use of terminal/linux commands in a tutorial environment
Mechanics Identified	● Story ● Progress / Levels ● Feedback / Guidance ● Steam Achievements

Game	Cyber Awareness Challenge
Game Type	Downloadable Training Simulator
Target Audience	Businesses Employees
Description	Single Player simulation of everyday life within the workplace and how to behave safely and responsibly
Key Teachings / Findings	- Teaches employees how to be safe in the workplace - Gives points for correct answers and guidance for both right and wrong answers
Mechanics Identified	● Tips / Hints ● Feedback / Guidance ● Story ● Points System